Homework Assignment 8 - Population Modeling [Due 4/3]

1) First I'd like you to do this math by hand in order to fully understand what the spreadsheet that we make that we will be doing.

Here are the initial conditions (the conditions on Day-0)

$S_0 = 100$ [Initially, there are 100 people susceptible to the infection.]

$I_0 = 1$ [Initially, there is only 1 infected person.]

$i = 0.9$ [The infection rate per day. Each infected person infects 90% of another person each day.]

I did Day-1 and a few other cells to get you started.
Fill in this table by doing the calculations. Round all answers to 2 places.

Day, $n =$	Susceptible Population $S_{n+1} = S_n - iI_n\left(\frac{S_n}{T}\right)$	Infected Population $I_{n+1} = I_n + iI_n\left(\frac{S_n}{T}\right)$	Total Population $S + I = T$	Ratio S_n/T $= \frac{S_n}{T}$
0	$S_0 = 100$	$I_0 = 1$	$100 + 1 = 101$	$= \frac{100}{101} = 0.99$
1	$S_1 = 100 - 0.9(1)\left(\frac{100}{101}\right) = 99.11$	$I_1 = 1 + 0.9(1)\left(\frac{100}{101}\right) = 1.89$	$99.11 + 1.89 =$ $= 101$	$= \frac{99.11}{101} = 0.98$
2	$S_2 = 97.44$	$I_2 = 1.89 + 0.9(1.89)\left(\frac{99.11}{101}\right) = 3.56$	101.00	
3		$I_3 = 6.65$	101.00	
4				
5	$S_5 = 79.08$	$I_5 = 21.92$	101.00	0.78
6	$S_6 = 63.63$		101.00	0.63
7			101.00	
8	$S_8 = 20.29$	$I_8 = 80.71$	101.00	0.20
9		$I_9 = 80.71 + 0.9(80.71)\left(\frac{20.29}{101}\right) = 95.30$		0.06
10	$S_{10} = 0.86$	$I_{10} = 100.14$		
11				
12		$I_{12} = 100.99$		
13	$S_{13} = 0.00$	101.00		0.00

2) Now, make the spreadsheet in GoogleSheets (or your preferred spreadsheet application). Here is the model you should duplicate: BLC-150 S-I Model in GoogleSheets.

Note: When using the link to the left, you'll be sent to a GoogleSheets page. On the bottom there are tabs to select from. Select "BLC-150 SI." You might have to scroll over to the right to see it.

To have access to this page, you'll need to be logged into your Bard Google account using your Bard email address.

I suggest that you open up a GoogleSheet in your own account and create your sheet while referring to my sheet and to the tutorial videos linked on the main assignment page.

Here is a screen shot with the formulas for the first few rows....

|	A	B	C	D	E
1	BLC-150 Modeling Sheet: SI		infection rate, i	0.9	= rate of inf/day
2					
3	Day	Susceptible Pop	Infected Pop	Total Pop	S/T
4	0	100.00	1.00	=B4+C4	=B4/D4
5	1	=B4-$D$1*C4*B4/D4	=C4+$D$1*C4*B4/D4	=B5+C5	=B5/D5
6	2	=B5-$D$1*C5*B5/D5	=C5+$D$1*C5*B5/D5	=B6+C6	=B6/D6
7	3	=B6-$D$1*C6*B6/D6	=C6+$D$1*C6*B6/D6	=B7+C7	=B7/D7
8	4	=B7-$D$1*C7*B7/D7	=C7+$D$1*C7*B7/D7	=B8+C8	=B8/D8

You will have to set up the Day numbers in column A. I suggest making about 60 days, but you could do whatever you want.

Then just type all you see from rows 1 to 5, you can then "click-drag-copy" B5-E5 down as far as you want. [Short video of Click-Drag-Copy]

Then select A3 to C? and make a chart to graph your data. [?- this number will depend on how many days you are modeling.] Find "Charts" in the "Insert Menu" to insert a graph/chart.
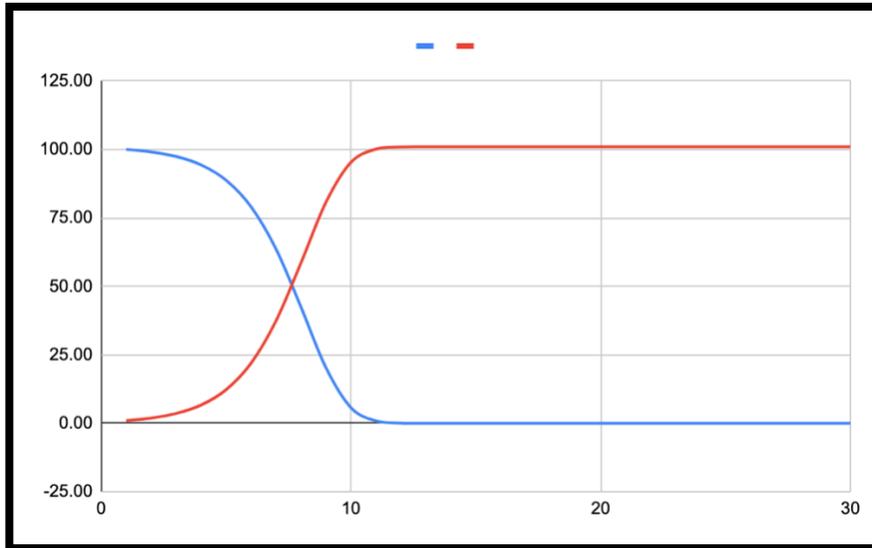
If you don't get a chart that looks like the one above, fiddle with the "Chart editor" menu. "Smooth line chart" works best for this sort of data. Charts can be very finicky and there are lots of confusing options to choose from.
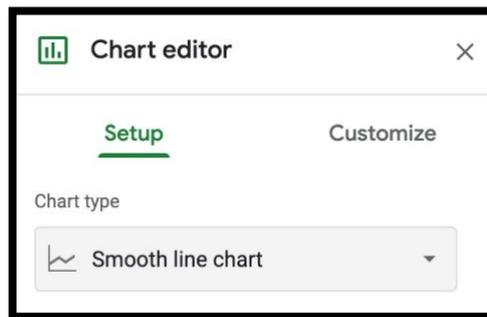
3) Once you have your sheet up and running, play with it. Input different i, S_0, and I_0 and try to interpret the results.

[If you couldn't get your sheet to work, just use the one I made here: BLC-150 S-I Model]

4) Finally... play with the "SIR" and the "SIR with ∂i" models on my GoogleSheets page. There are various inputs in these models. See what inputs give the most interesting outputs. Think about zombie infections or rabies or CoVid19. These models are found in the tabs at the bottom of the window.

That's it. Enjoy.

Outline of what you need to do to complete this PDF.

1) Fill in the table on p1. [I'll post answers later.]
2) Make an S-I Model in GoogleSheets (or similar spreadsheet)
3) Play with the S-I Model.
4) Play with the SIR Models